A Hybrid System for Chest Pain Analysis

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Two techniques for automated decision making are combined: a knowledge-based system and a neural network model. This combination allows information to be derived both from experts and from accumulated data. The application can be changed by replacement of the rule-base in the knowledge-based component, and replacement of the training database for the neural network model. The system is illustrated here in two cardiology applications.

INTRODUCTION

Decision support systems have utilized a number of techniques, including pattern classification, knowledge-based systems, and neural networks [1-2]. The system described here combines the knowledge-based approach with a neural network model, allowing both expert-derived knowledge and data-derived knowledge to be included in the same system [3]. This interaction takes place in a number of ways, outlined below. The system is implemented on IBM-PC compatibles, with a choice of interfaces geared to the level of sophistication of the user.

SYSTEM STRUCTURE

Knowledged-Based System

The knowledge-based portion of the system features a modified production rule in which weighting factors indicate the relative importance of each contributing parameter. In addition, partial presence of symptoms is allowed. Techniques from approximate reasoning are utilized in order to determine the degree of rule substantiation. This portion of the system has been tested extensively over the last decade [3].

Neural Network Model

The neural network model is a three-level feed-forward model based on a non-statistical learning supervised learning algorithm developed by the authors [3]. Input data can be of any ordered form, including binary, categoric, integer, or continuous. The network can categorize data into two or more classes, and also produces a degree of membership for each class.

Hybrid System

The hybrid system utilizes the interaction of these two approaches in a number of ways, each of which is briefly described: 1) The neural network model may be used to determine weighting factors for rule antecedents in the knowledge-based system; 2) Rule thresholds can be determined through neural network modeling utilizing techniques similar to degree of membership determinations discussed above; 3) Weighting factors from the neural network model can be used to extract which parameters are important in arriving at specific decisions. This information in turn can be used to derive rules for the knowledge-based model; 4) Expert-derived knowledge can be used to pre-determine appropriate structures for the neural network model, resulting in increased efficiency and shorter development time.

Applications

The system will be demonstrated in two applications: emergency room chest pain analysis and use of exercise testing data to determine degree of coronary artery disease.

CONCLUSION

The hybrid approach to expert system development allows more rapid implementation of new application areas through the use of the automated training algorithm. A user-friendly front-end makes the type or reasoning transparent to the end-user. This technique is useful not only for decision making systems, but also for computer-assisted instruction. The system has been extensively tested for the cardiology applications, and has consistently yielded sound medical advice.

Reference

[1]. P. Szolovits, *Artificial Intelligence in Medicine*, AAAS, Boulder, CO, 1982.

[2]. R. Sabbatini, Appl. of connectionist systems in biomedicine, *MEDINFO*, Elsevier, 1992, 418-425.

[3]. D. Hudson, M. Cohen, et al., Medical Diagnosis and treatment plans derived from a hybrid expert system, in *Hybrid Architectures for Intelligent Systems*, A. Kandel et al., Eds., CRC Press, 1992, 329-344.

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